Ceanothus greggii A. Gray (Rhamnaceae), *Adenostoma sparsifolium* Torr. (Rosaceae), *Arctostaphylos peninsularis* Wells (Ericaceae), *Artemisia tridentata* Nutt. (Asteraceae), *Quercus chrysolepis* Liebm. and *Q. dumosa* Nutt. (Fagaceae), and *Pinus jefferyi* Grev. & Balf. (Pinaceae).

On 27 and 29 October 1989 the unmated females were caged at a site in the vicinity of Mike's Sky Ranch in the Sierra San Pedro Mártir, approximately 170 km south of the international border. Despite sunny weather and at a similar elevation and floral community, no males were attracted.

Two males were deposited as voucher specimens in both of the following institutions: Universidad Autonoma de Baja California Norte, Ensenada, Mexico, and the Essig Museum of Entomology, University of California, Berkeley. Eleven specimens are in the private collection of John Noble, Anaheim Hills, California; the remaining 22 specimens are in the collection of the author.

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POSITIVE RELATION BETWEEN BODY SIZE AND ALTITUDE OF CAPTURE SITE IN TORTRICID MOTHS (TORTRICIDAE)

Additional key words: North America, biometrics, ecology.

Earlier I reported a positive correlation between forewing length and altitude of capture site in the Nearctic tortricid *Eucosma agricolana* (Walsingham) (Miller, W. E. 1974, Ann. Entomol. Soc. Amer. 67:601–604). The all-male sample was transcontinental, with site altitudes ranging from near sea level on east and west coasts to more than 2700 m in the Rocky Mountains. Altitudes of capture came from labels of some specimens, and from topographic maps for others. Forewing length increased 0.33 mm through each 500 m of site altitude. Forewing length is a reliable indicator of dry body weight, hence of body size (Miller, W. E. 1977, Ann. Entomol. Soc. Amer. 70:253–256).

More recently, I noticed at the American Museum of Natural History several series of other tortricid species with altitude labels. These numbered 34 or more specimens per sex or per species, and had been collected during the 1970's in New Mexico, Utah, Colorado, Wyoming, Idaho, Nevada, and Montana by the F. H. Rindge family. To extend the earlier work, I analyzed forewing length of these series with respect to altitude of capture site. Here forewing length is the maximum distance between wing base (excluding tegula) and tip (including fringe). The present study differs from the earlier one in three ways that are noteworthy: it involves three species, the data represent a smaller geographic area, and all altitudes are taken from labels.

I investigated each sex independently in *Choristoneura occidentalis* Freeman and *Pseudosciaphila duplex* (Walsingham), but combined the sexes in *Hystricophora asphodelana* (Kearfott), which does not exhibit marked sexual size dimorphism. In testing for correlation, I used Kendall's tau, a distribution-free, nonparametric rank-order statistic, as well as the more familiar Pearson product-moment correlation coefficient, r.

All five samples show evidence of positive correlation between forewing length and altitude of capture site (Table 1). Tau values for all five are positive, and three tau values are significantly ($P < 0.05$) greater than 0; r values for four samples are positive, and two r values are significantly ($P < 0.05$) greater than 0. I ruled out latitude as a hidden factor in the correlation because north and south partitions of the samples differed negligibly

TABLE 1. Relation between forewing length and altitude of capture site in five samples of three tortricid species.

Species Sex	N	Range in: Altitude (A) (m)	Range in: Forewing length (F) (mm)	Test statistics: tau	P	r	P	Mean change in forewing length/500 m altitude (mm)[a]
Choristoneura occidentalis								
Female	36	1890–2896	10.0–14.0	0.30	<0.05	0.13	>0.10	0.05
Male	55	1798–3277	9.6–14.0	0.24	<0.05	0.16	>0.10	0.08
Pseudosciaphila duplex								
Female	34	1798–2896	10.0–14.0	0.19	≃0.10	−0.04	>0.10	−0.02
Male	53	1798–2804	9.5–13.0	0.07	≃0.10	0.37	<0.01	0.09
Hystricophora asphodelana								
Mixed	45	1219–3048	9.5–15.0	0.27	<0.05	0.45	<0.01	0.13

[a] Rounded slope (b) values of regressions of the form F = a + bA.

in mean forewing length, the largest difference in any sample being only 6%. Mean increase in forewing length per 500 m of altitude (Table 1) is 0.07 mm for the five samples.

These results, together with the earlier report, bring to four the number of tortricid species showing evidence of the correlation; no tortricid species checked so far has shown a clear absence of it. I know of no other reports concerning body size and altitude in Tortricidae.

For other lepidopterans, negative correlations between body size and altitude have been reported for *Occidryas chalcedona* (Doubleday) (Nymphalidae) (Hovanitz, W. 1942, Ecology 23:175–188), *Parnassius phoebus* (Fabricius) (Papilionidae) (Guppy, C. S. 1986, Can. J. Zool. 64:956–962), and *Polites draco* (Edwards) (Hesperiidae) (Brown, F. M. 1962, J. Lepid. Soc. 16:239–242). All of these are diurnal species. In diurnal lepidopterans, body sizes converge in alpine environments in accordance with body heat capacity (Douglas, M. 1986, The lives of butterflies, Univ. Michigan Press, Ann Arbor, 214 pp.). Thus positive as well as negative correlations with altitude are theoretically possible in butterflies.

In tortricids, which are crepuscular, the correlation may have a different explanation. It doubtless involves one or more of the well-known altitudinal gradients in temperature, solar radiation, and barometric pressure, with these factors acting directly, or indirectly through food plants. One likely indirect effect concerns nitrogen, which may be more abundant in plants at high altitudes (Körner, C. 1989, Oecologia 81:379–391). Nitrogen content of food is well known as a determinant of insect body size (Mattson, W. J. & J. M. Scriber 1987, pp. 105–146, *in* Slansky, F. & J. G. Rodriguez [eds.], Nutritional ecology of insects, mites, and spiders, Wiley, New York, 1016 pp.). In a phytophagous hymenopteran, positive correlations have been demonstrated in the same study among all three variables—altitude, pupal weight, and food-plant nitrogen content (Niemelä, P., M. Rousi & H. Saarenmaa 1987, J. Appl. Entomol. 103:84–91).

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